IS23x-MA

Version 1.0

Intelligent Step Motor

TECHNOSOFT

Intelligent Motor

Technical Reference

Preliminary

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IS23x-MA
v1.0
Technical Reference

P091.036.IS23x-MA.UM.0507

Technosoft S.A.
Buchaux 38
CH-2022 Bevaix, NE
Switzerland
Tel.: +41 (0) 32 732 5500
Fax: +41 (0) 32 732 5504
contact@technosoftmotion.com
www.technosoftmotion.com/

Read This First

About This Manual

This book is a technical reference manual for the **IS23x** intelligent servo drive. It describes the **IS23x** operation and provides basic information needed to program the IS23x in the Technosoft Motion Language (**TML**) environment.
Both versions are fully electrical-, mechanical- and software-compatible. The changes between the two versions consist only in a different placement of the connectors on the backside of the motor.

Except where clearly shown, this manual applies to both versions.

Notational Conventions

This document uses the following conventions:

- The Technosoft Motion Language will be referred to as TML
- TML variables, parameters or instructions are shown in special italic typeface. Here is a sample:

  SETIO#4 IN;
  UPD;

Information about Cautions

This book may contain cautions.

CAUTION ! This is an example of a caution statement.
A caution statement describes a situation that could potentially cause harm to you, or to the IS23X intelligent servo drive unit

Related Documentation from Technosoft

MotionChip™ II TML Programming (part no. P091.055.MCII.TML.UM.xxxx) describes in detail TML basic concepts, motion programming, functional description of TML instructions for high level or low level motion programming, communication channels and protocols. Also give a detailed description of each TML instruction including syntax, binary code and examples.

MotionChip II Configuration Setup (part no. P091.055.MCII.STP.UM.xxxx) describes the MotionChip II operation and how to setup its registers and parameters starting from the user application data. This is a technical reference manual for all the MotionChip II registers, parameters and variables.

Help of the EasyMotion Studio software platform – describes how to use the EasyMotion Studio – the complete development platform for IS23x-MA which support all new features added to revision H of firmware. It includes: motion system setup & tuning wizard, motion sequence programming wizard, testing and debugging tools like: data logging, watch, control panels, on-line viewers of TML registers, parameters and variables, etc.

Help of the IPM Motion Studio software platform – describes how to use the IPM Motion Studio – the complete development platform for IS23x-MA. It includes: motion system setup & tuning wizard, motion sequence programming wizard, testing and debugging tools like: data logging, watch, control panels, on-line viewers of TML registries, parameters and variables, etc.

If you Need Assistance …

If you want to …	Contact Technosoft at …
Visit Technosoft online	World Wide Web: http://www.technosoftmotion.com/
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Make suggestions about or report errors in documentation (see Note)	Mail: Technosoft SA Buchaux 38 CH-2022 Bevaix, NE Switzerland

Note: You need to register your **IS23x** system in order to get free assistance and support. Use the License No. of the IPM Motion Studio.

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1. Key Features

- Available in 2 motor lengths, models IS232 and IS233
- Logic and Motor power supply: 12-48V$_{DC}$;
- 1.5K×16 internal SRAM memory
- 8K×16 E^2ROM to store TML programs and data
- RS232 interface, up to 115kbps communication speed
- Isolated CAN-Bus 2.0B interface up to 1Mbit/s
- 7 Isolated digital I/Os (0…24V):
  - 4 dedicated or general-purpose inputs:
    - ENABLE input (configurable as general-purpose)
    - Limit Switch - Positive input (configurable as general-purpose)
    - Limit Switch - Negative input (configurable as general-purpose)
    - Not-Autorun input
  - 1 general-purpose output
- 1 analog input, +/-10 V
- On-board Ready LED
- On-board thermal sensor
- Integrated Protections for over current, over temperature, i^2t, control error
- Operating ambient temperature: 0-40°C

2. IS23x-MA Connection Diagrams

2.1. Connectors Diagram

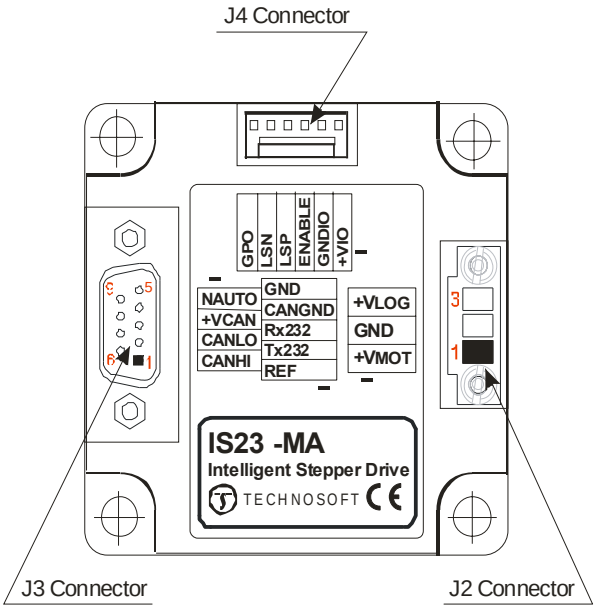


Figure 2.1. *IS23x-MA drawing – backward view*

2.2. IS23x-MA - Connector pins description

2.2.1. J2 connector

Pin	Pin name	TML name	Type	Function / Alternate function / Comments
1	**$+V_{MOT}$**	-	I	Motor supply - $12V_{MIN}$ … $48V_{MAX}$
2	**GND**	-	-	Ground
3	**$+V_{LOG}$**	-	I	Logic supply - $24V_{TYP}$, $12V_{MIN}$ … $48V_{MAX}$

2.2.2. J3 connector

Pin	Pin name	TML name	Type	Function / Alternate function / Comments
1	**REF**	AD5	I	Analog reference input - 0…5 V
2	**Tx232**	-	O	RS232 Transmit
3	**Rx232**	-	I	RS232 Receive
4	**CANGND**	-	I	CAN-Bus isolated ground
5	**GND**	-	-	Ground
6	**CANHI**	-	-	CAN-Bus Positive; isolated - referred to “CANGND”
7	**CANLO**	-	-	CAN-Bus Negative; isolated - referred to “CANGND”
8	**+VCAN**	-	-	CAN-Bus isolated supply; $24V_{TYP}$, $12V_{MIN}$ … $36V_{MAX}$
9	**NAUTO**	-	-	Not-Autorun - Strap to GND and reset, in order to stop automatical execution of TML program

2.2.3. J4 connector

Pin	Pin name	TML name	Type	Function / Alternate function / Comments
1	**+VIO**	-	-	Input / output isolated supply
2	**GNDIO**	-	-	Input/output isolated ground
3	**ENABLE**	IN#16	I	Enable digital input
4	**LSP**	IN#2	I	Limit switch “P” input; isolated; 0 … 24V referred to “GNDIO”
5	**LSN**	IN#24	I	Limit switch “N” input; isolated; 0…24V referred to “GNDIO”
6	**GPO**	OUT#14	O	General purpose output; isolated; PNP output from “+VIO”

2.3. Analog inputs connection

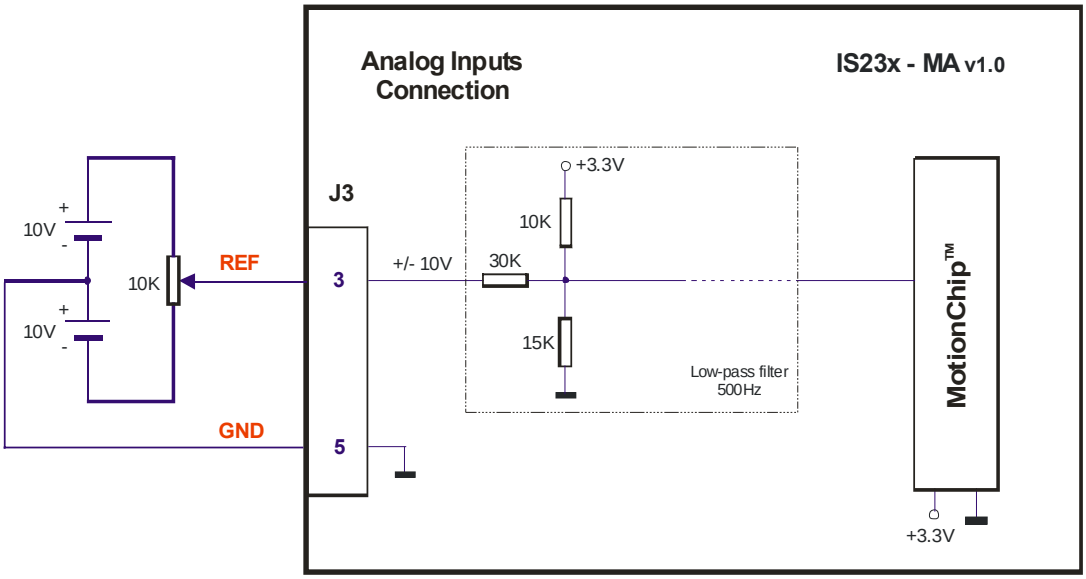


Figure 2.2. *IS23x-MA Analog input connection*

2.4. Digital I/O connection

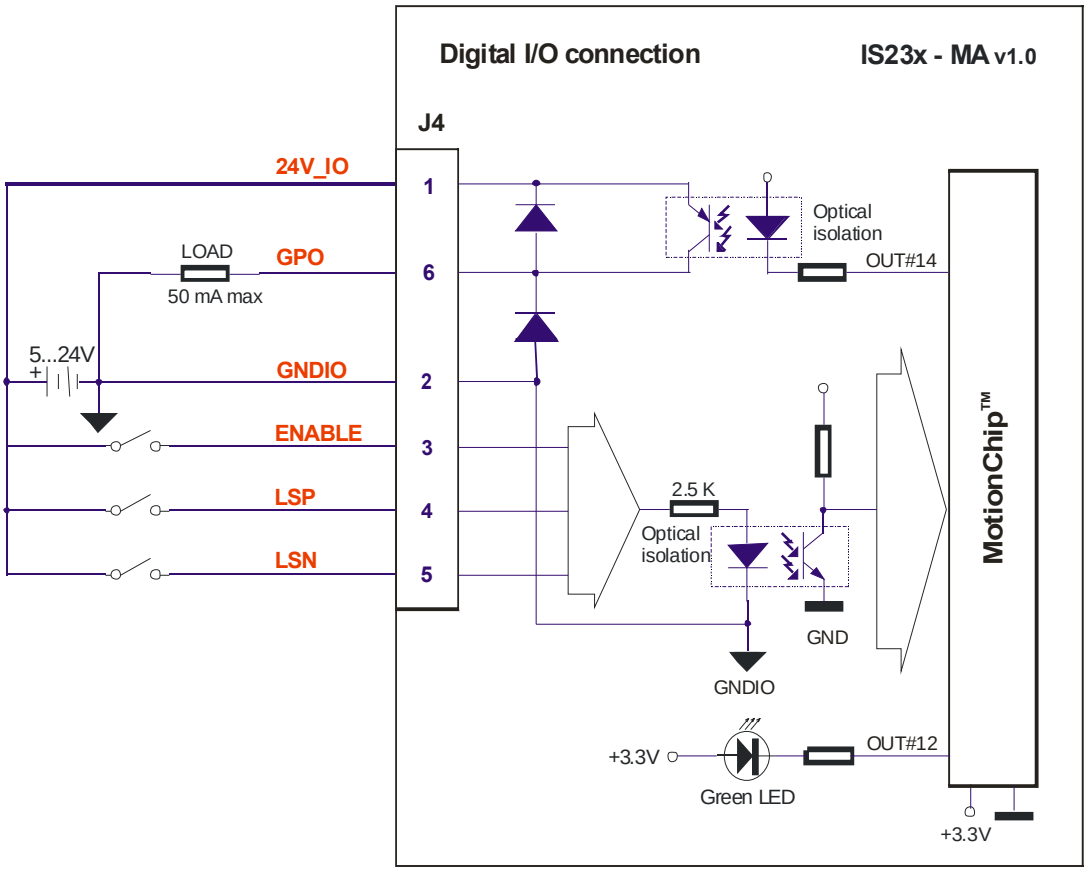


Figure 2.3. *IS23x-MA Digital I/O connection*

2.5. Supplies connections

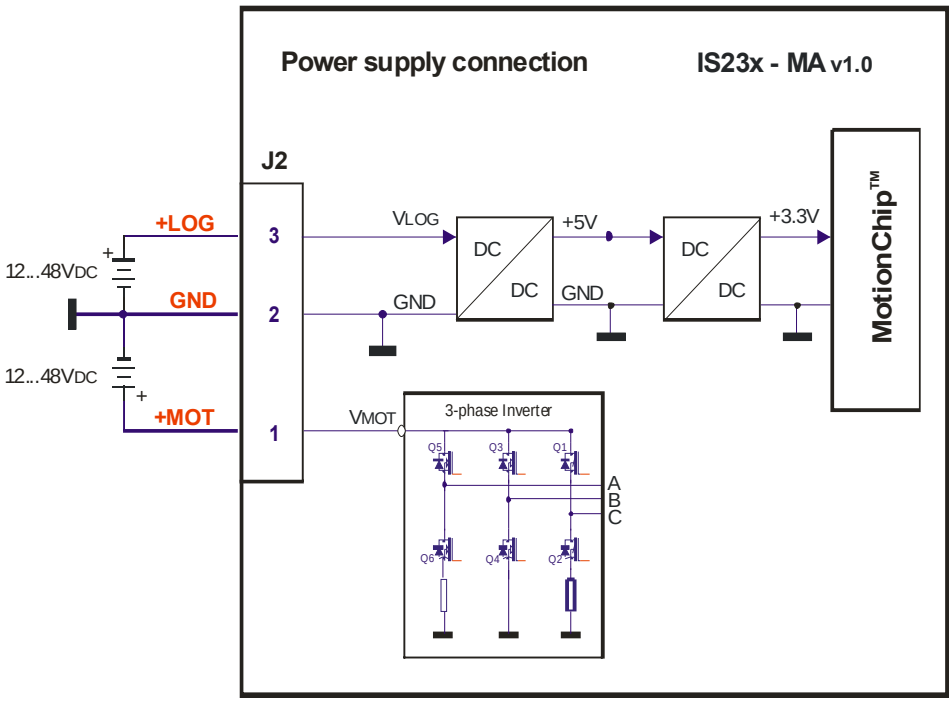


Figure 2.4. *IS23x-MA Power supply connection*

2.6. Serial RS-232 connection

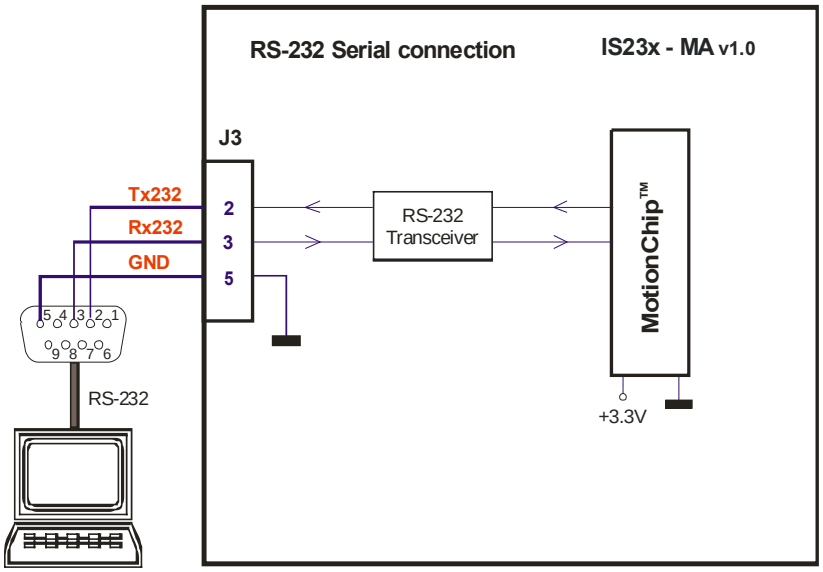


Figure 2.5. *IS23x-MA Serial RS-232 connection*

2.7. CAN connection

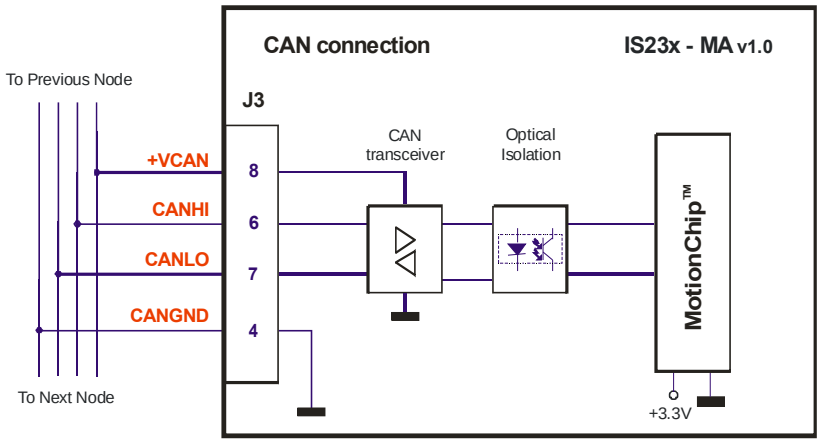


Figure 2.6. *IS23x-MA CAN connection*

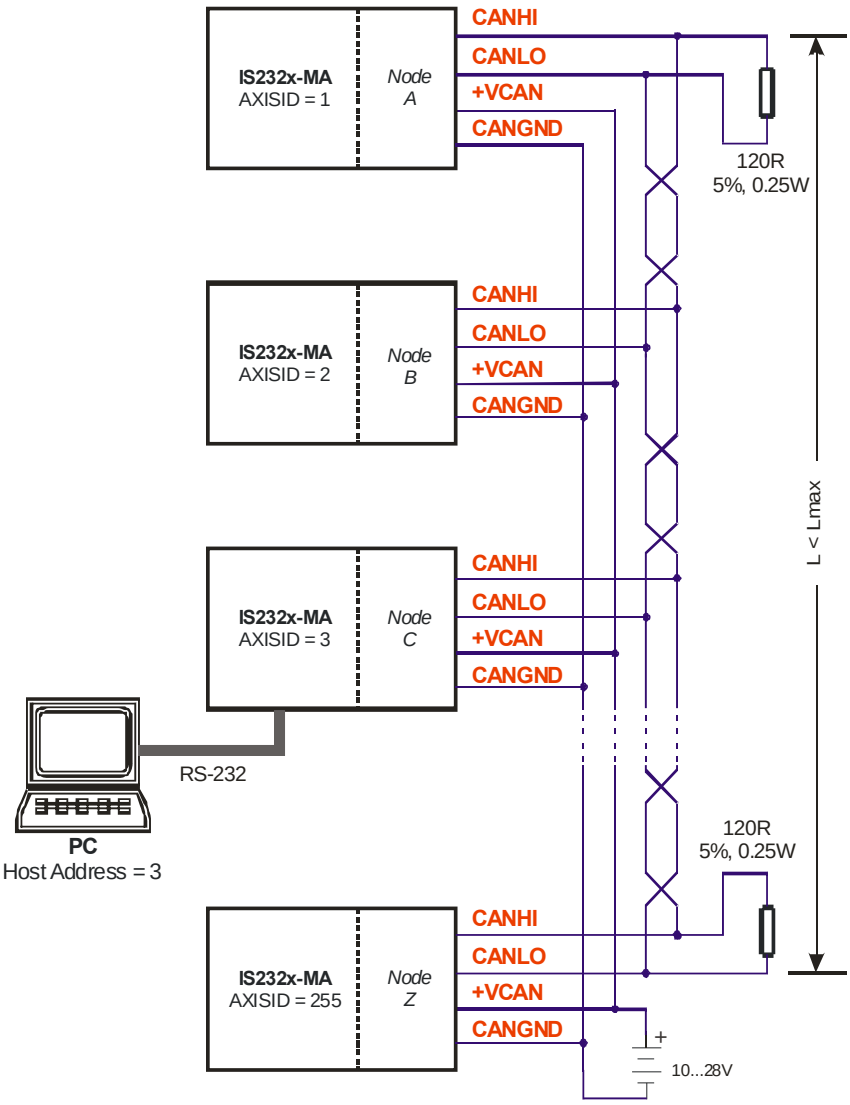


Figure 2.7. *Multiple-Axis CAN network*

Note1: The CAN network requires a 120-Ohm terminator. This is not included on board.
Note2: CAN signals are isolated from other IS23x circuits.

2.8. Special connection (Not-Autorun)

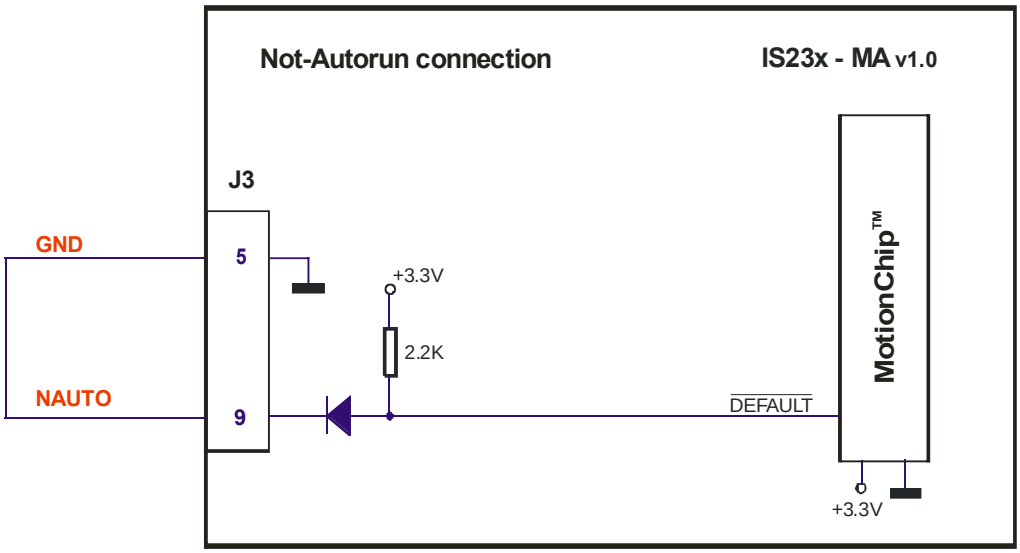


Figure 2.8. *Special connection (Not-Autorun)*

At power-on, the Intelligent Motor automatically executes a TML program located in the E2ROM memory, at address 0x4000. The special connection presented here can be used to stop the automatical execution of this TML program.

3. IS23x-MA Electrical Specifications

Electrical characteristics:

All parameters measured under the following conditions (unless otherwise noted):

T_{amb} = 25°C, logic supply (V_{LOG}) = 24V_{DC}, motor supply (V_{MOT}) = 24V_{DC} ;
Supplies start-up / shutdown sequence: *-any-* ;

Logic Supply Input

All voltages referred to ***GND***		Min.	Typ.	Max.	Units
Supply voltage	Nominal values	12	24	48	V_{DC}
	Absolute maximum values, continuous †	0		55	V_{DC}
	Absolute maximum values, surge (duration ≤ 10mS) †	-0.5		65	V
Supply current	Normal operation		200	350	mA

Motor Supply Input

All voltages referred to ***GND***		Min.	Typ.	Max.	Units
Supply voltage	Nominal values	12		48	V_{DC}
	Absolute maximum values, continuous, including ripple & braking-induced over-voltage †	0		55	V_{DC}
	Absolute maximum values, surge (duration ≤ 10mS) †	-0.5		65	V
Supply current	Idle		0.5	1	mA
	Operating	0		2.8	A

I/O Supply Input

All voltages referred to ***GND_IO***		Min.	Typ.	Max.	Units
Supply voltage	Nominal values	12		24	V_{DC}
	Absolute maximum values, continuous †	-30		+30	V_{DC}
	Absolute maximum values, surge (duration ≤ 10mS) †	-50		35	V
Supply current	Normal operation		50	75	mA
Isolation voltage	Between GND and GND_IO			50	V_{RMS}

CAN-Bus Supply Input

All voltages referred to ***GND_CAN***		Min.	Typ.	Max.	Units
Supply voltage	Nominal values	12		24	V_{DC}
	Absolute maximum values, continuous †	-30		+30	V_{DC}
	Absolute maximum values, surge (duration ≤ 10mS) †	-50		+35	V
Supply current	Normal operation		40	80	mA
Isolation voltage	Between GND and GND_CAN			500	V_{RMS}

Isolated Digital Inputs (ENABLE, LSP, LSN)

All voltages referred to ***GND_IO***		Min.	Typ.	Max.	Units
Input voltage	Logic "LOW"	-5	0	0.5	V
	Logic "HIGH"	12	24	V_{LOG}	
	Absolute maximum, surge (duration ≤ 1S) †	-12		+65	
Input current	Logic "HIGH"	4	10	25	mA
	Logic "LOW"			0.5	
Input impedance	Referred to GND_IO		2.5		KΩ
Input frequency		0		5	KHz
Pulse width	0→1→0 or 1→0→1	100			μS

Isolated Digital Outputs (GPO)

All voltages referred to ***GND_IO***		Min.	Typ.	Max.	Units
Output voltage	Logic "HIGH"; Output crt. = 50mA	V_{LOG}-3	V_{LOG}-1		V
	Absolute maximum, continuous †	-0.5		V_{LOG} + 0.5V	
Output current	Logic "HIGH"; Output voltage ≥V_{LOG}-3V	50	60		mA
	Logic "LOW" (leakage current)			0.1	
Clamp diodes current	Output voltage ≤ (-0.5V) or ≥ (V_{LOG}+0.5V); Absolute maximum, continuous †	-100		+100	
Output frequency	External load 1KΩ to GND_IO	0		5	KHz
Pulse width	0→1→0 or 1→0→1; no external load ($5V_{PP}$)	100			μS
Short-circuit protection		Yes			

Analog Inputs (REF)

All voltages referred to ***GND***		Min.	Typ.	Max.	Units
Resolution			10		bits
Differential linearity	Guaranteed 10-bits no-missing-codes			0.09	% FS[1]
Offset error			±0.5	±2	% FS[1]
Gain error			±0.5	±3	% FS[1]
Bandwidth (-3dB)			250		Hz
Input voltage Operating range	REF	-10		+10	V
Input voltage Absolute Maximum, continuous †	REF	-15		V_{LOG}	V
Input impedance	REF		30		KΩ
External potentiometer	Recommended resistance	10	10	20	KΩ

RS-232

All voltages referred to ***GND***		Min.	Typ.	Max.	Units
Standards compliance		TIA/EIA-232-C			
Bit rate	Depending on software settings	9600		115200	Baud
ESD Protection	Human Body Model (100pF, 1.5 KΩ)			±15	KV
Input voltage	RX232 input	-25	-	+25	V
Output short-circuit withstand	TX232 output to GND	Guaranteed			

CAN-Bus

All voltages referred to ***GND_CAN***		Min.	Typ.	Max.	Units
Standards compliance		CAN-Bus 2.0B error active; ISO 11898-2			
Recommended transmission line impedance	Measured at 1MHz	90	120	150	Ω
Bit rate	Depending on software settings	125K		1M	Baud
Number of network nodes	Depending on software settings			64	-
ESD Protection	Human Body Model			±15	KV

Others

		Min.	Typ.	Max.	Units
Operating temperature		0		40	°C
Weight	IS232-MA		0.7		Kg
	IS233-MA		1.1		
Storage temperature	Not powered	-40	85	°C	
Humidity	Not condensing	0	90	%RH	

Motor parameters

	IS232	IS233	Units
Step angle	**1.8°**	**1.8°**	**°**
Step angle accuracy (full step, no load)	**± 5%**	**± 5%**	**%**
Rated Voltage	**2.3**	**3.2**	**V**
Current / Phase	**2.8**	**2.8**	**A**
Resistance / Phase	**0.83**	**1.13**	**Ω**
Inductance / Phase	**2.2**	**3.6**	**mH**
Detent Torque	**35**	**72**	**mNm**
Holding torque	**1.01**	**1.89**	**Nm**
Rotor Inertia	**276**	**480**	**g-cm²**
Weight	**0.65**	**1**	**Kg**

[1] "FS" stands for "Full Scale"

† Stresses beyond those listed under "absolute maximum ratings" may cause permanent damage to the device. Exposure to absolute-maximum-rated conditions for extended periods may affect device reliability.

4. Torque - Speed Diagrams

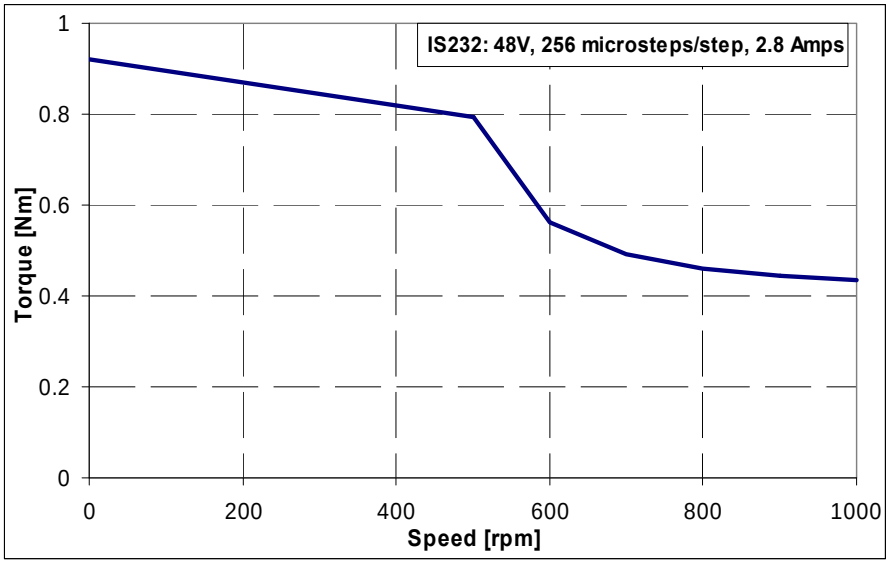


Figure 4.1. IS232-MA Torque vs. Speed diagram

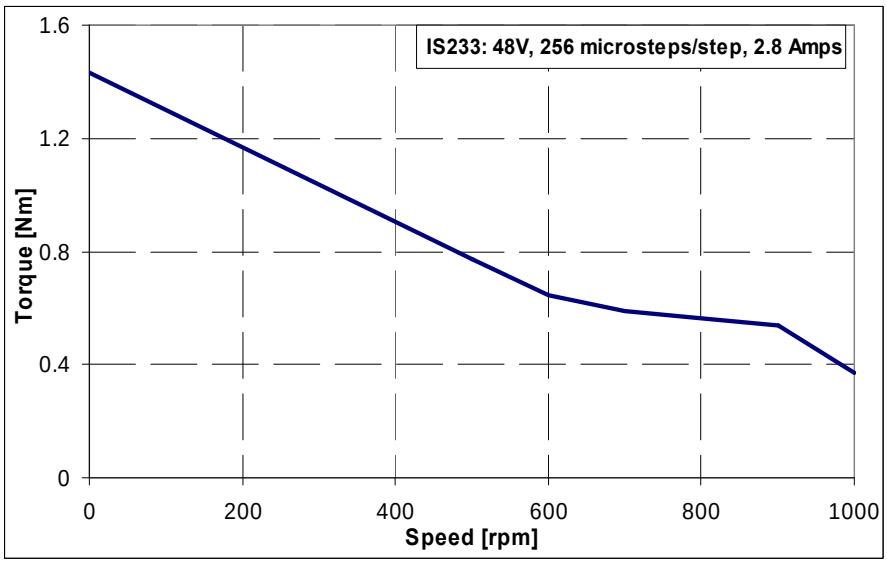
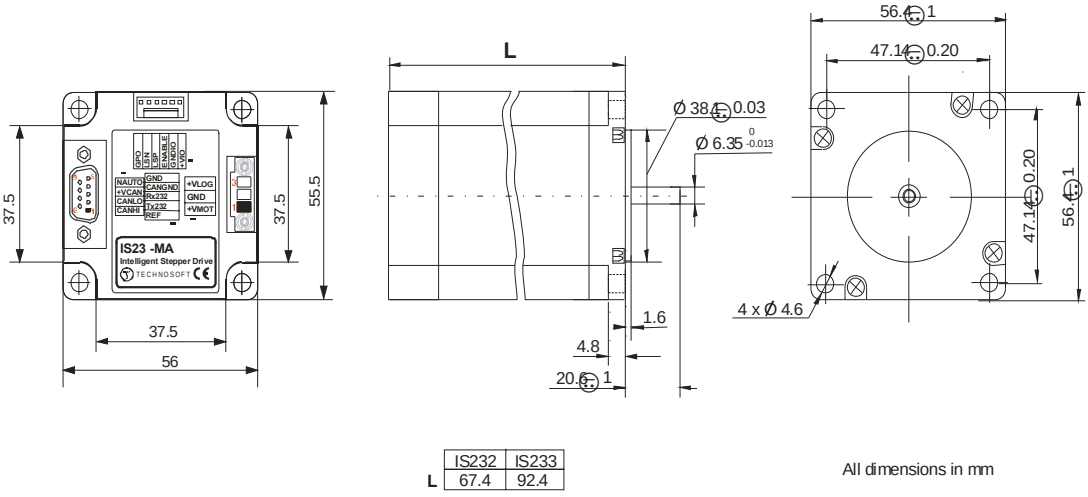


Figure 4.2. IS233-MA Torque vs. Speed diagram

5. IS23x-MA Dimensions



L	IS232	IS233
	67.4	92.4

All dimensions in mm

Figure 5.1. IS23x-MA Dimensions

6. Mating Connectors

Connector	Manufacturer	Part number	Details
J2	Phoenix Contact	MC1,5/3-STF-3,81	3-pin screw-terminal plug, 3.81mm-pitch
J3	Fischer Elektronik	DS-09-L	Sub-D 9-pin male
J4[1]	Molex	22-01-3067	6-pin housing
	Molex	08-52-0123	Crimp pins

[1] The mating connector for J4 has 2 components: housing and crimp pins.

7. Scaling factors

7.1. Supply / DC-bus Voltage Measurement Scaling

The IS23x includes a supply / DC-bus voltage feedback. In the TML environment, the A/D converted value of the supply / DC-bus voltage feedback can be read as the TML variable *AD4*.

The scaling factor for the DC-bus voltage measurement is:

$$\text{DC-bus [V]} = \frac{V_{mm}[V]}{65472[bits]} \times \text{AD4 } [bits]$$

where:

V_{mm} is the maximum measurable DC-bus voltage; this value is 60.74 V
65472 is the AD4 value for DC-bus voltage = V_{mm}

Remark: *AD4* value is the result of a 10-bit A/D conversion, left-shifted by 6. The 6 LSB of *AD6* are always 0. If the A/D conversion result varies by 1 LSB, this translates into a variation of the *AD4* value by $2^6 = 64$.

7.2. Motor Currents Scaling

The IS23x measures motor currents through shunts placed in the lower-legs of the inverter. Only currents measured on phases A and B are connected to 2 A/D inputs, with a current gain factor of 0.1 V/A. The shunt from phase C is used only to sense a short-circuit. In applications with 3-phase AC motors, the TML variables *IA* and *IB* provide the motor currents in phases A and B. In applications with DC or brushless DC motors, TML variable *IQ* gives the motor current. The scaling factor for the motor currents is:

$$\text{Motor current [A]} = \frac{1.65[V]}{32704[bits] \times 0.27[V/A]} \times \text{TML current [bits]}, \text{ or}$$

$$\text{Motor current [A]} = \frac{6.11[A]}{32704[bits]} \times \text{TML current [bits]}$$

Remark: The A/D conversion result has 10-bit resolution and is used left-shifted by 6. The 6 LSB of TML currents are always 0. If the A/D conversion result varies by 1 LSB, this translates into a variation of the TML current value by $2^6 = 64$.

7.3. Motor Speed Scaling

In **open loop** operation, the speed is expressed in micro-steps/speed loop sampling period.
The speed in steps/s can be computed with the following formulas:

$$\text{Speed [micro-steps / s]} = \frac{1}{Ts_S} \times \text{speed [IU]}$$

$$\text{Speed [steps/s]} = \frac{1}{Ts_S \times No_usteps_step} \times \text{speed [IU]}$$

The above relation refers to the following TML parameters and variables:

- **CSPD** – the speed command for position or speed profiles
- **TSPD** – the target speed, i.e. the speed reference computed by the reference generator
- **EREF** – the speed reference when external reference mode is set for speed control

Example: If the speed loop sampling period is Ts_S = 0.8 ms and the step motor control is done with 256 micro-steps/step, a speed reference of 1024 micro-steps / Ts_S means:

1024 / 256 steps / 0.8 ms = 4 steps / 0.8 ms = 5000 steps/s

7.4. Motor Position Scaling

In **open loop** operation, the position is expressed in micro-steps.

The position in steps can be computed with the following formula:

Position [micro-steps] = position [IU]

$$\text{Position [steps]} = \frac{1}{No_usteps_step} \times \text{position [micro-steps]}$$

The above relation refers to the following TML parameters and variables:

- **CPOS** – the position command for position or speed profiles
- **TPOS** – the target position, i.e. the position reference computed by the reference generator
- **EREF** – the position reference when external reference mode is set for position control

Example: If a step motor has n_steps = 200 steps/rev and the step motor control is done with 256 micro-steps/step, a position reference of 25600 micro-steps means:

25600 / 256 steps = 100 steps = 0.5 revolution

7.5. Drive Temperature Scaling

The IS23x-MA have built-in temperature sensors. TML variable *AD7* gives the drive temperature. The scaling factor is:

$$\text{Drive temperature [°C]} = \frac{3.3[V]}{65472[bits] \times 0.01[V/°C]} \times AD7\ \text{[bits]} - 50\ \text{[°C]}$$

8. Available Memory Areas

The IS23x-MA has 2 types of memory: a 1.5K×16 SRAM (internal) memory and an 8K×16 serial E^2ROM (external) memory.

The SRAM memory is mapped both in the program space (from 8270h to 87FFh) and in the data space (from A70h to FFFh). The data memory can be used for real-time data acquisition and to temporarily save variables during a TML program execution. The program space can be used to download and execute TML programs. It is the user's choice to decide how to split the 1.5-K SRAM into data and program memory.

The E^2ROM is seen as 8K×16 program memory mapped in the address range 4000h to 5FBEh. It offers the possibility to keep TML programs in a Non-volatile memory. Read and write accesses to the E^2ROM locations, as well as TML programs downloading and execution, are done from the user's point of view similarly to those in the SRAM program memory. The E^2ROM SPI serial access is completely transparent to the user.

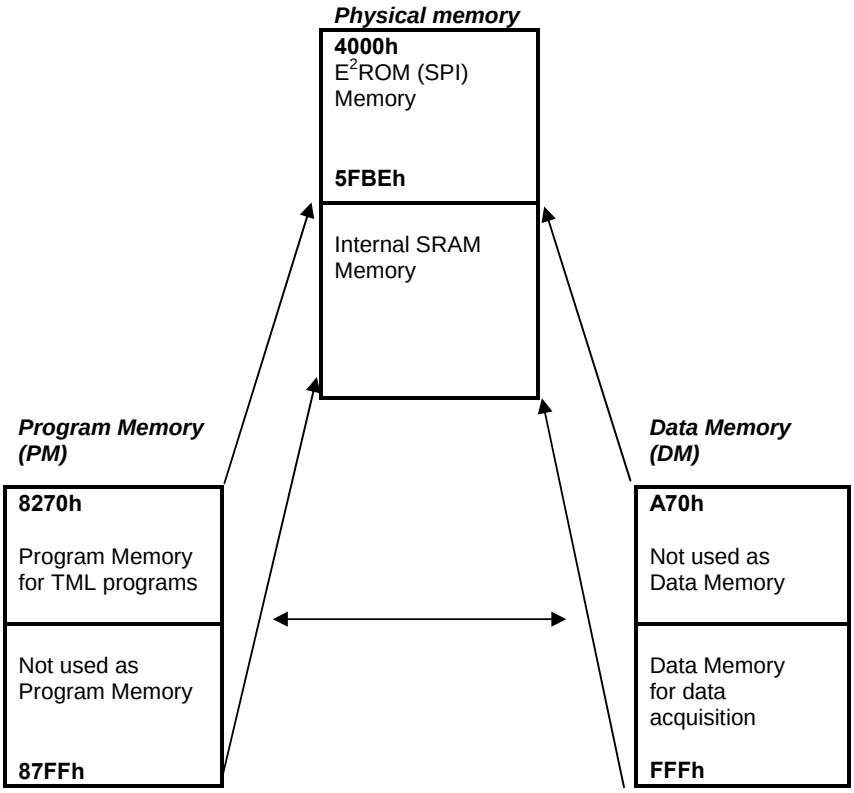


Figure 8.1. *IS23x Memory Map*

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